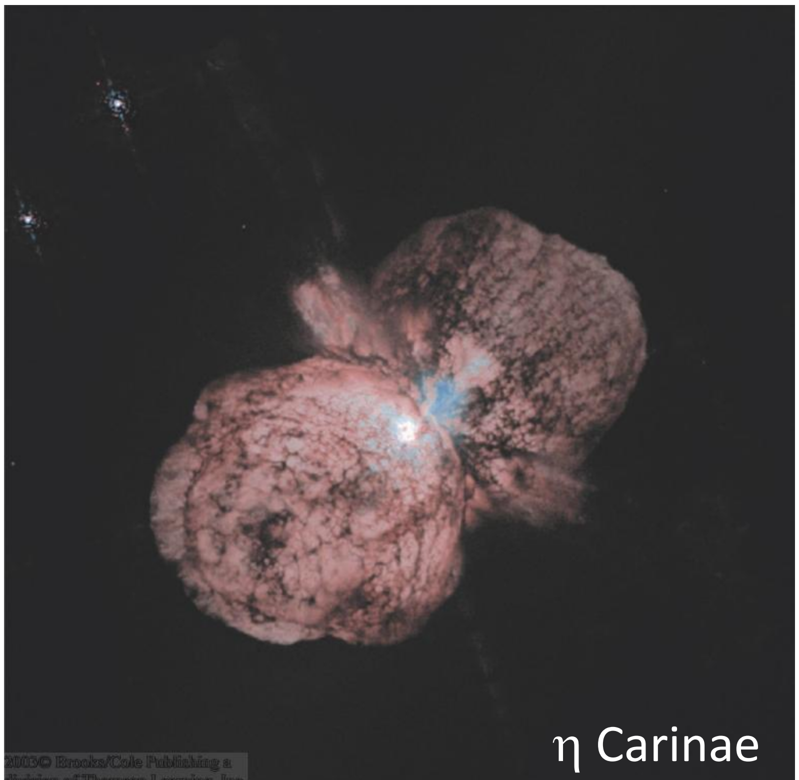
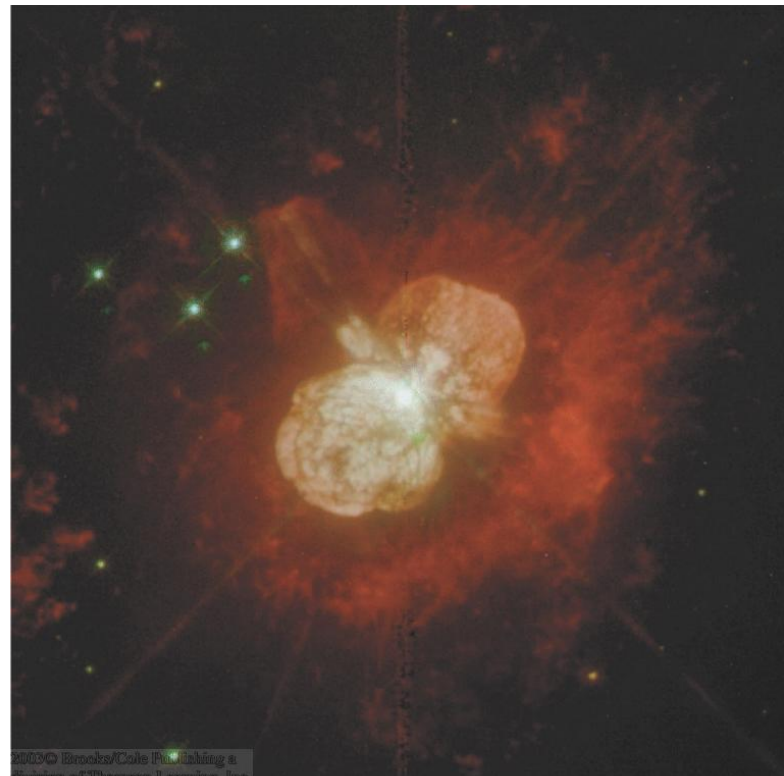
Maximum Masses of Main Sequence Stars

$M_{max} \sim 100\ M_{\odot}$

- More massive clouds fragment into smaller pieces during star formation
- Very massive stars lose mass in strong stellar winds



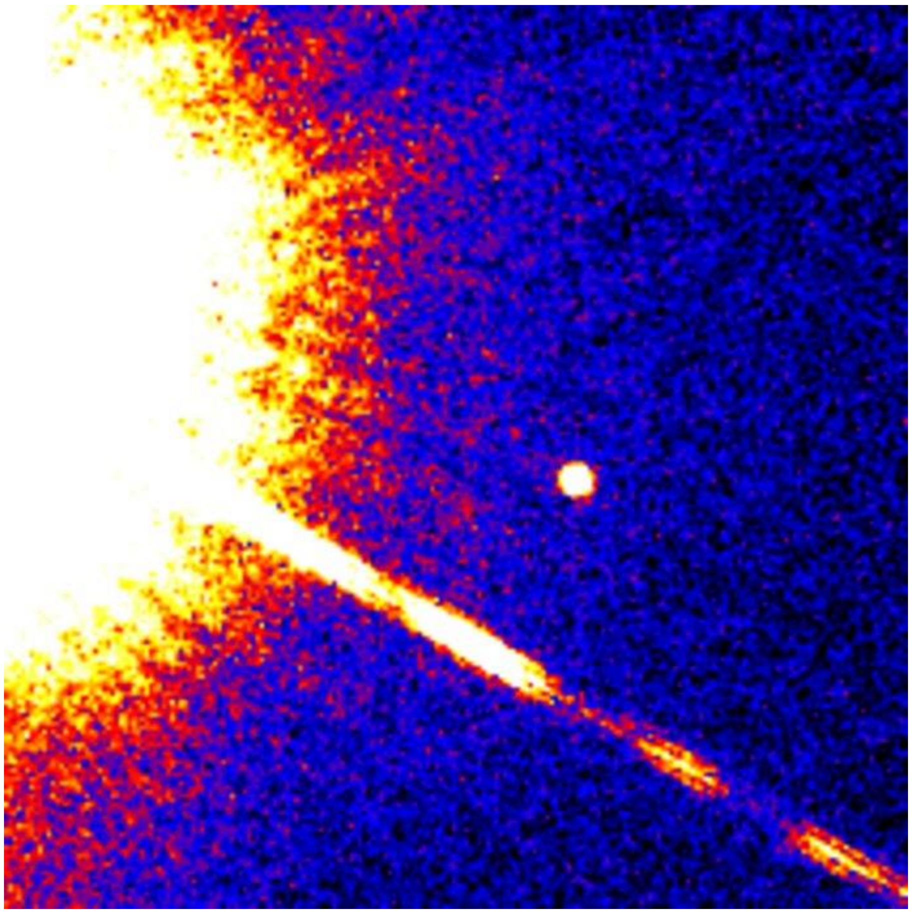


Example: η Carinae: Binary system of very massive stars

Dramatic mass loss; major eruption in 1843 created double lobes

Minimum Mass of Main-Sequence Stars

$$M_{min} \sim 0.08\ M_\odot$$



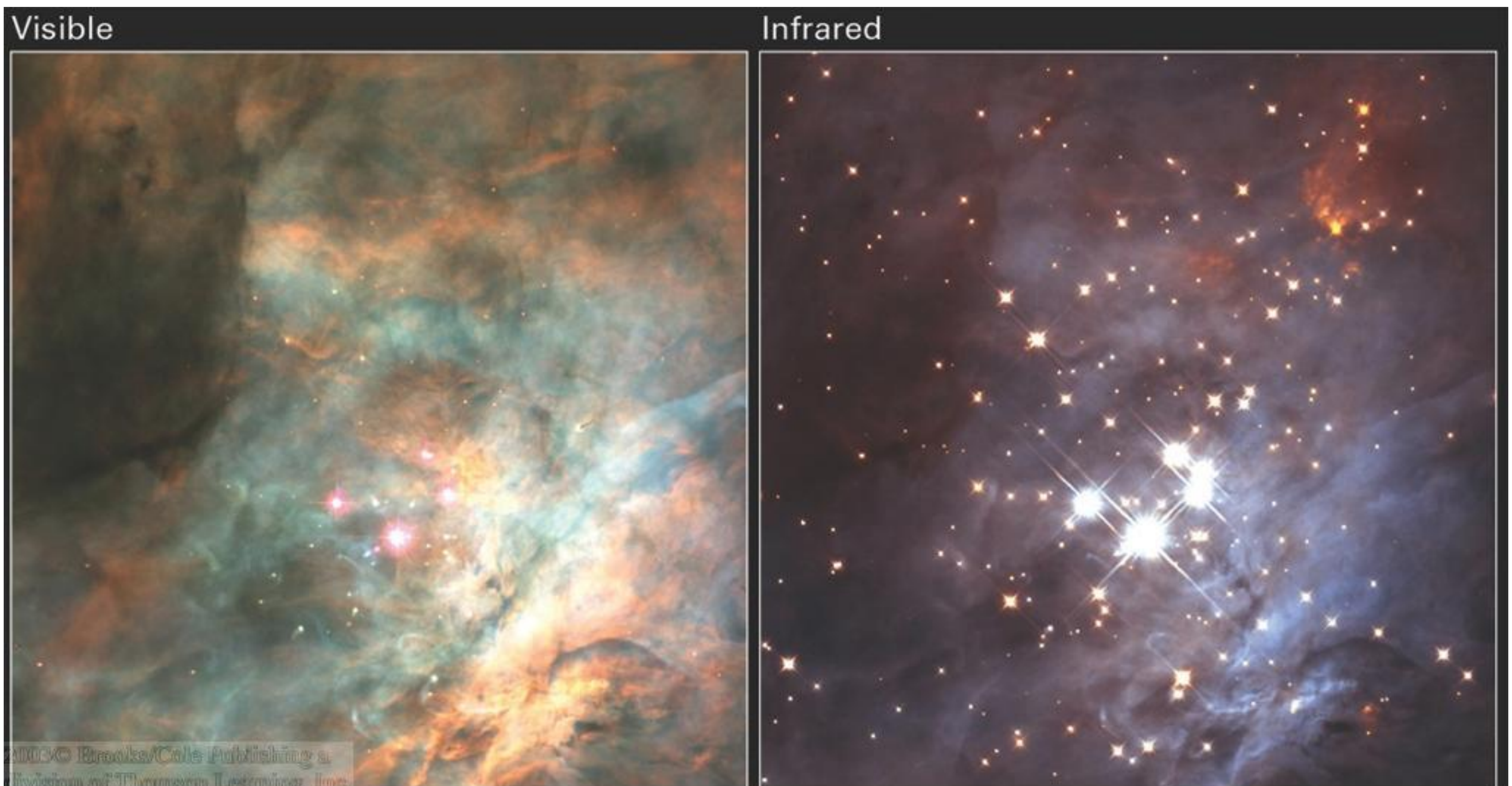
Gliese 229B, HST

At masses below 0.08 $M_\odot$, stellar progenitors do not get hot enough to ignite thermonuclear fusion

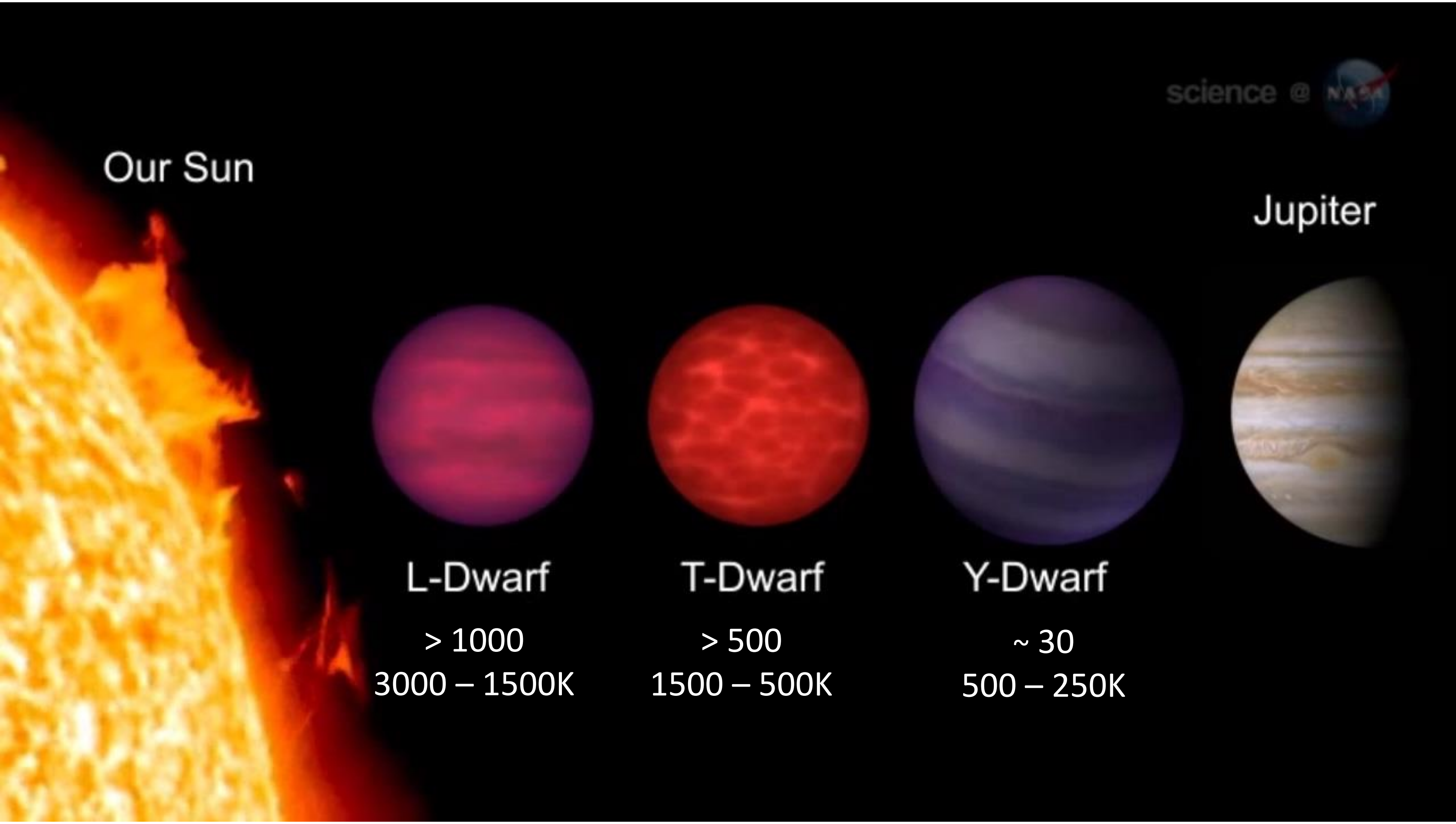
$\rightarrow$ Brown Dwarfs

Brown Dwarfs

- Hard to find because they are very faint and cool; emit mostly in the infrared
- Many have been detected in *star forming regions* like the Orion Nebula

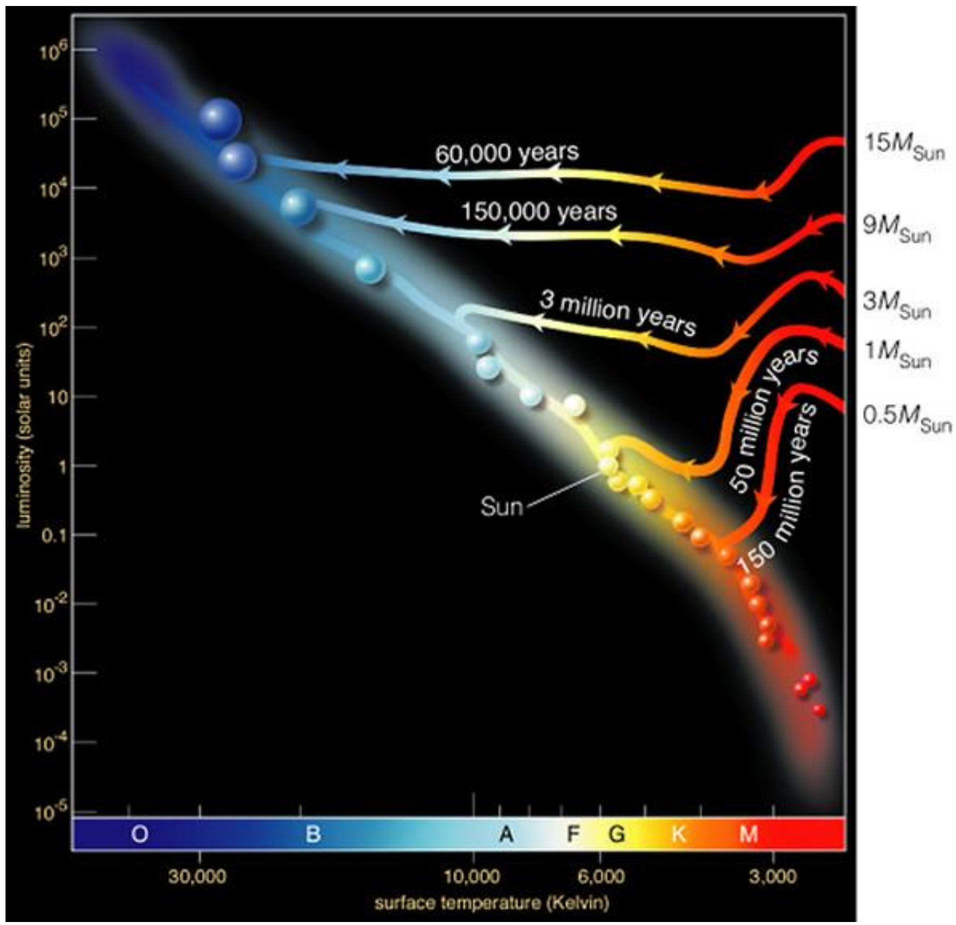


Brown Dwarfs



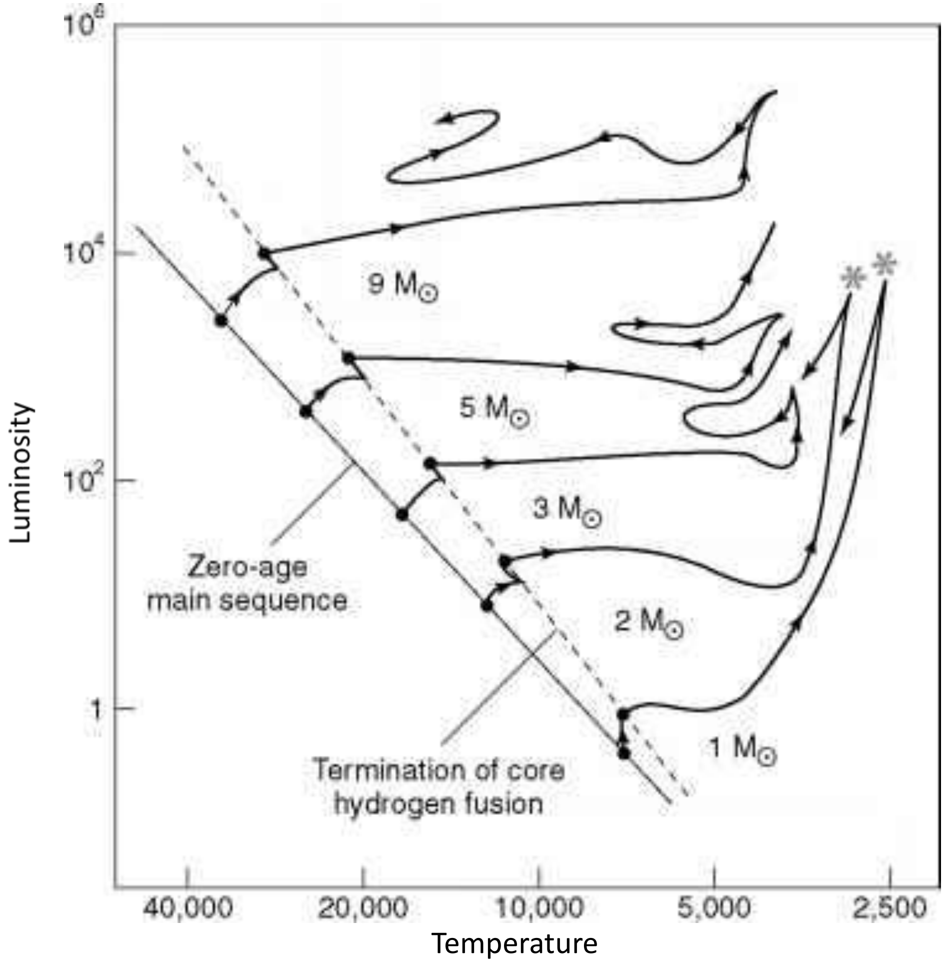
Zero – Age Main Sequence (ZAMS)

The temperature and luminosity at which a star for a given mass ignites hydrogen fusion in the core



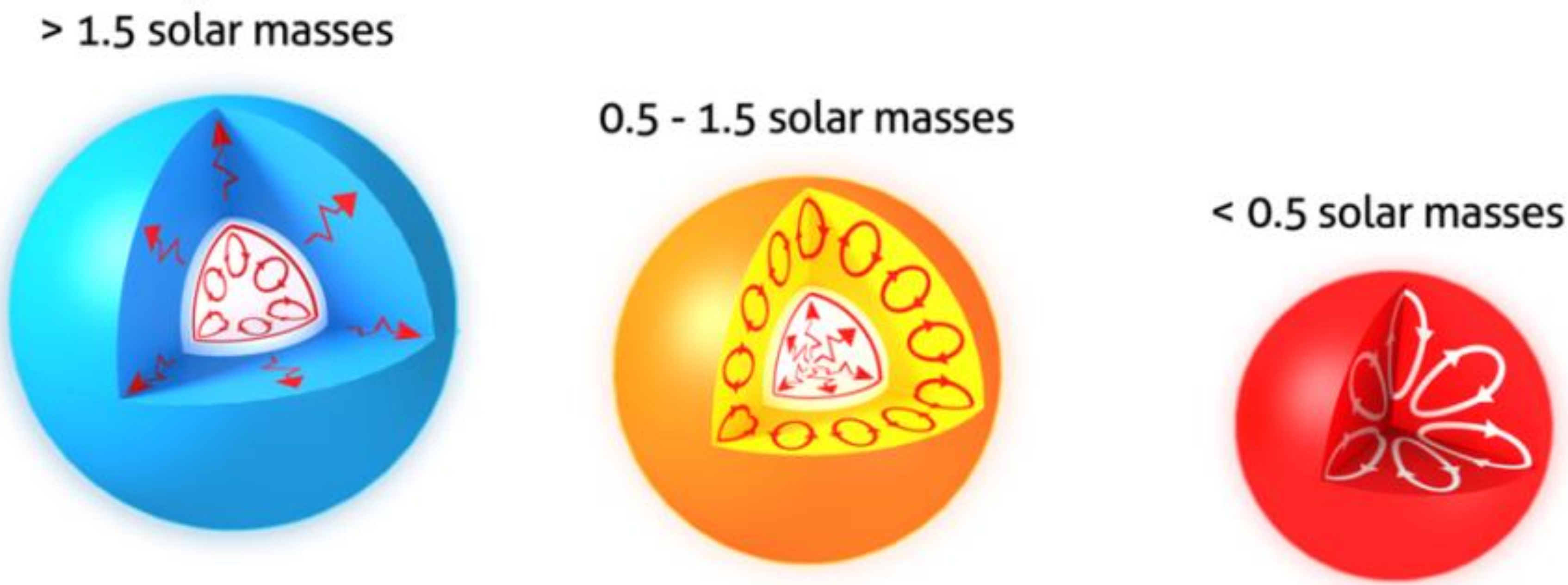
Terminal – Age Main Sequence (TAMS)

The temperature and luminosity at which a star for a given mass no hydrogen is left in the core

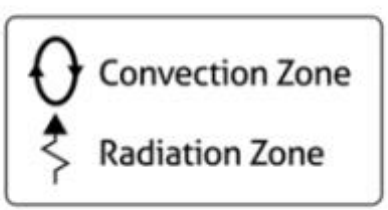


The duration of a star's main sequence lifetime depends on the rate at which the hydrogen is consumed in the core and energy lost by radiation from the surface

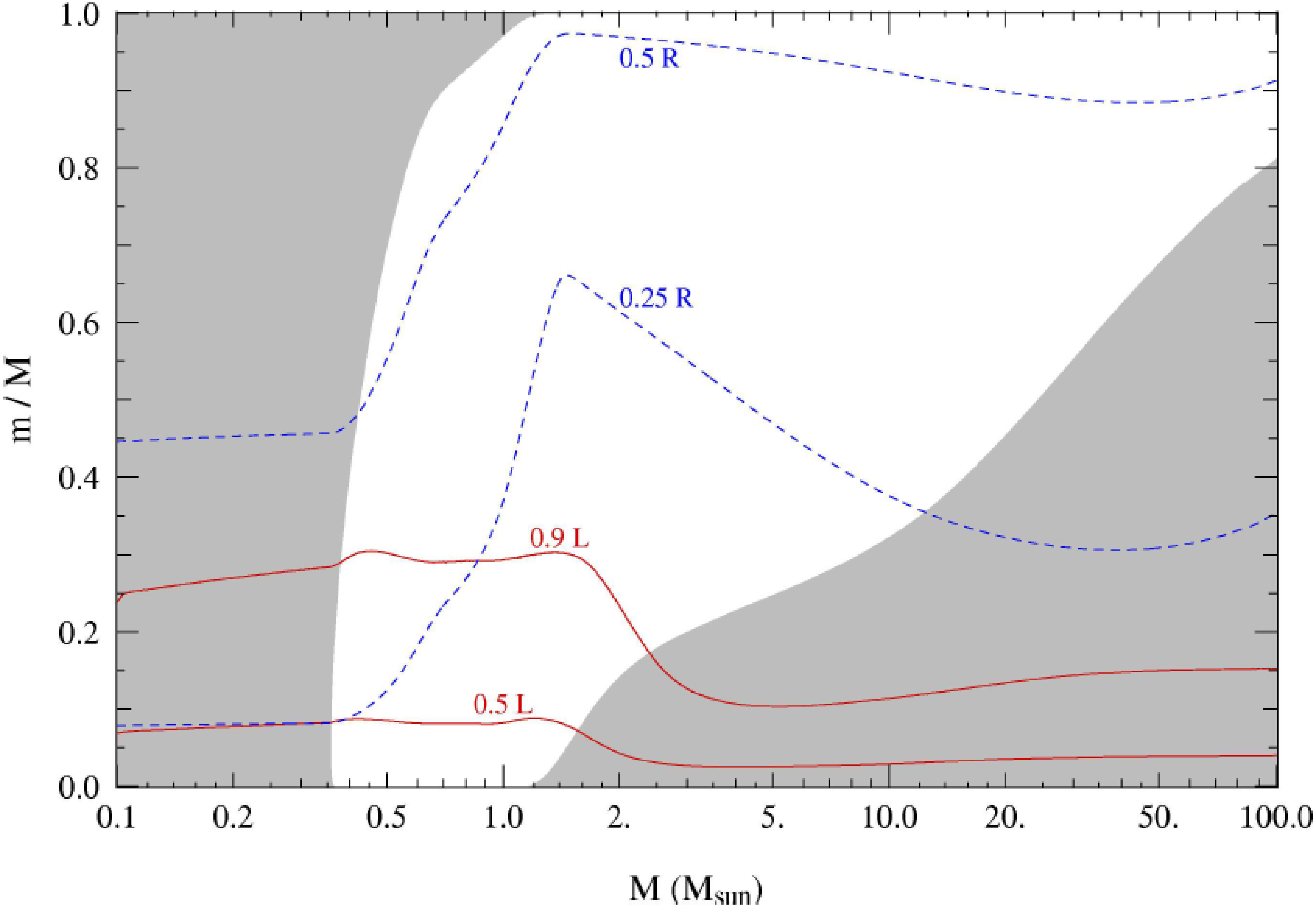
- The more massive a star, the shorter is its main-sequence lifetime



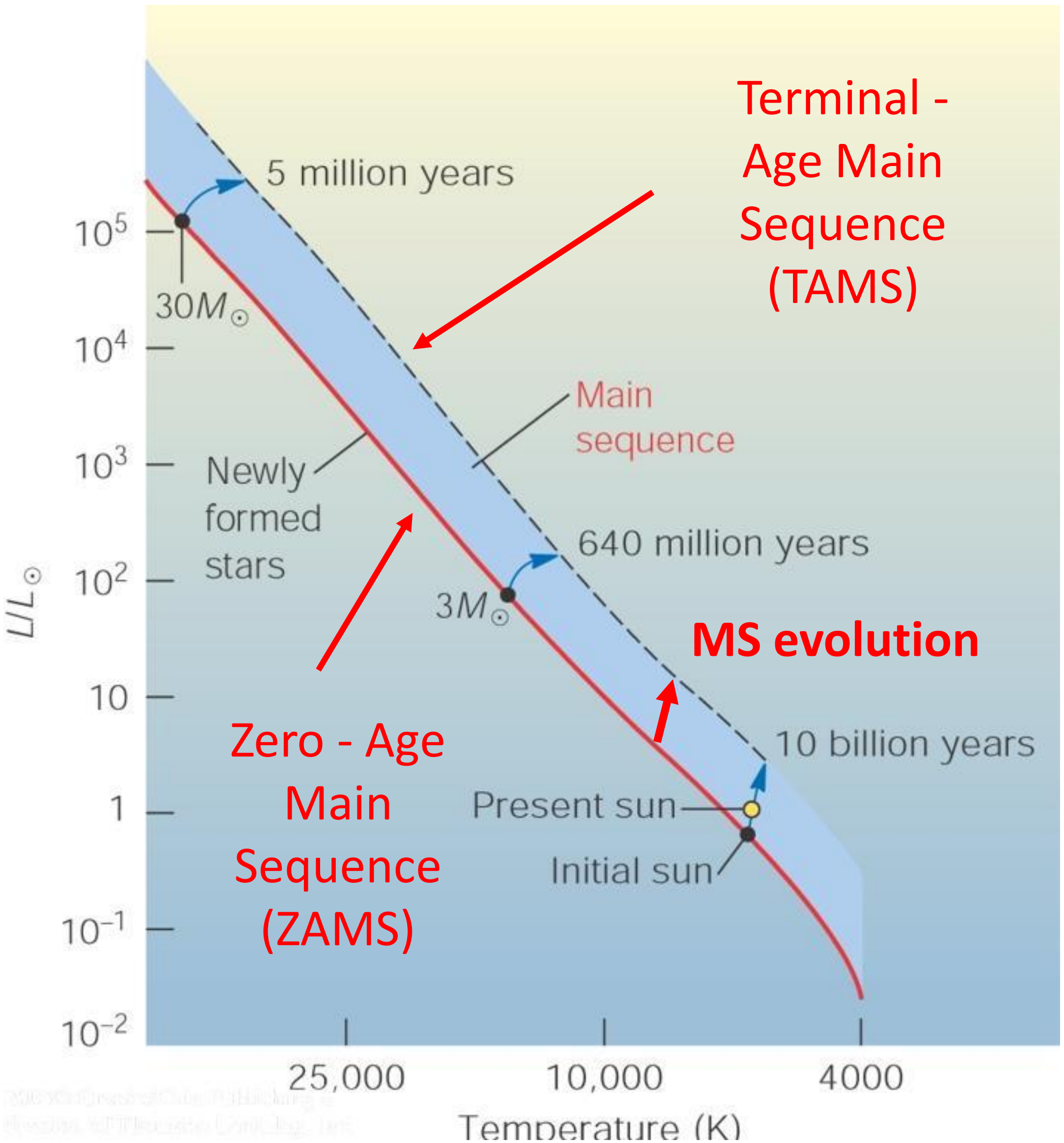
hotter than F2	F2 – M0	cooler than M0
hotter than 6800 K	6800 – 3900 K	cooler than 3900 K



Convection in Stars



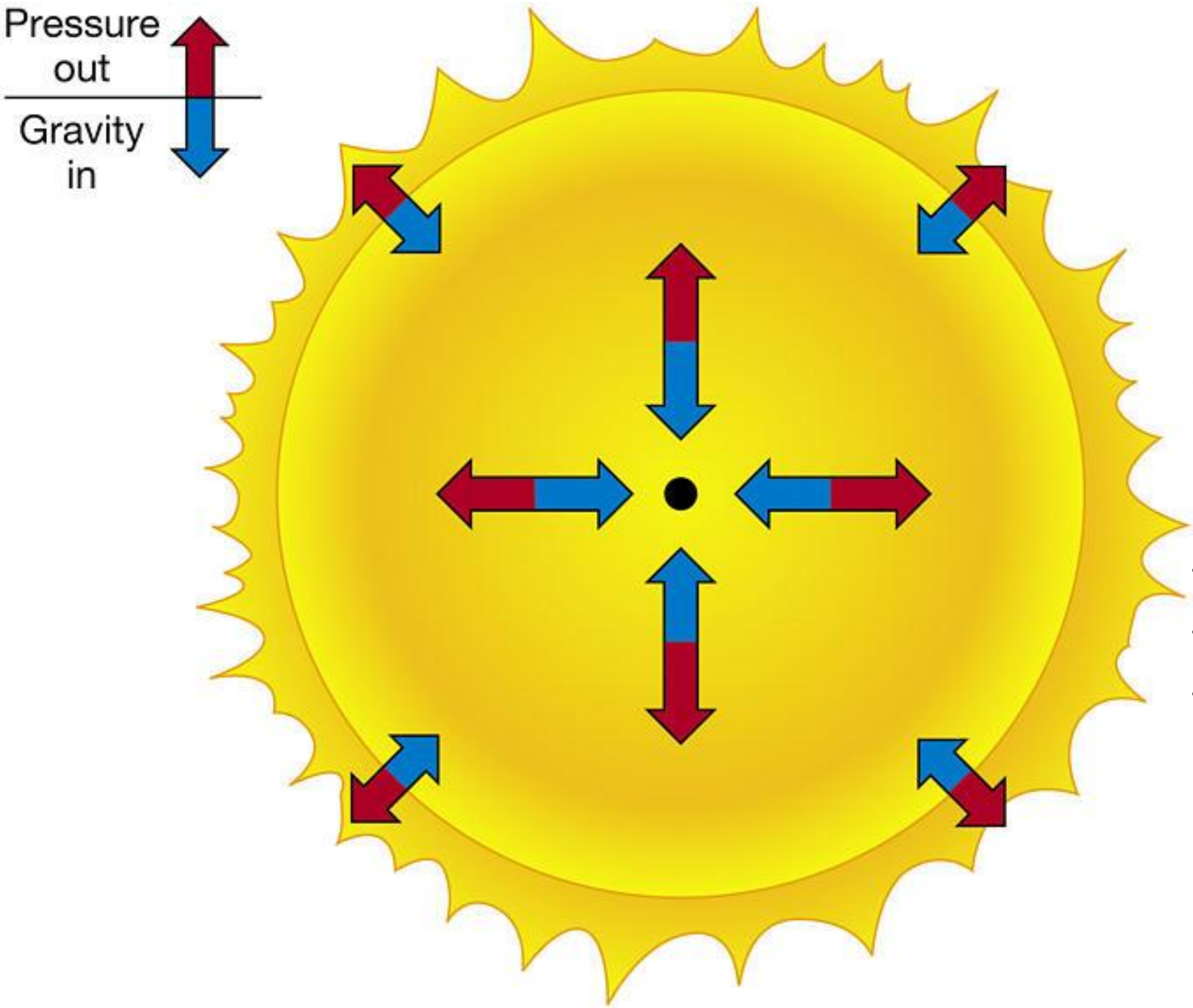
Evolution on the Main Sequence



Main Sequence stars are core hydrogen burning stars in *hydrostatic equilibrium*

Finite supply of H => finite life time

Hydrostatic Equilibrium



If the rate of energy generation in the core slows down, gravity wins out over pressure and the star begins to contract. This contraction increases the temperature and pressure of the stellar interior, which leads to higher energy generation rates and a return to equilibrium.

Evolution on the Main Sequence

A star's **life time *t*** ~ energy reservoir / luminosity

Mass ($M_\odot$)	Surface temperature (K)	Spectral class	Luminosity ($L_\odot$)	Main-sequence lifetime (10^6 years)
25	35,000	O	80,000	4
15	30,000	B	10,000	15
3	11,000	A	60	800
1.5	7000	F	5	4500
1.0	6000	G	1	12,000
0.75	5000	K	0.5	25,000
0.50	4000	M	0.03	700,000

Energy reservoir ~ M

Luminosity $L \sim M^{3.5}$

$$t \sim M/L \sim 1/M^{2.5}$$

Massive stars have shorter life times